



# **KIBABII UNIVERSITY**

**UNIVERSITY EXAMINATIONS  
2021/2022 ACADEMIC YEAR**

**SECOND YEAR FIRST SEMESTER  
MAIN EXAMINATIONS**

**FOR THE DEGREE OF B.Sc. (CHEMISTRY)**

**COURSE CODE: SCH 213**

**COURSE TITLE: BASIC CHEMICAL THERMODYNAMICS**

**DATE: 25/01/2022**

**TIME: 8-10AM**

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**INSTRUCTIONS TO CANDIDATES:**

TIME: 2 Hours

Answer **Question ONE** and **any TWO** of the remaining

KIBU observes ZERO tolerance to examination cheating

**QUESTION ONE (30 Marks)**

(a) Define the following terms

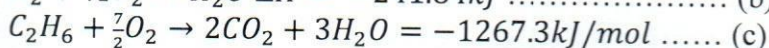
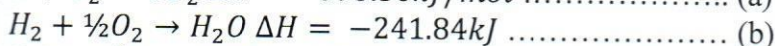
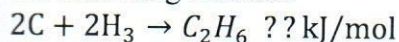
- i. Thermodynamics (2Marks)
- ii. System (2Marks)
- iii. Adiabatic process (2Marks)
- iv. Isochoric process (2Marks)

(b) From the ideal gas equation  $pv = nRT$ , deduce Vander Waal equation of state

(3Marks)

(c) Using the information given in equations *a*, *b*, and *c* below, calculate the enthalpy of the following reaction

(3Marks)



(d)(i) Define heat capacity

(2Marks)

(ii) Starting with  $E = q - W$ , show that the heat capacity at constant volume is given by

$$C_v = \left( \frac{dE}{dT} \right)$$

(3Marks)

(e) (i) State the Carnot theorem

(2Marks)

(ii) Calculate the minimum amount of heat that must be withdrawn from hot reservoir at 137°C to obtain work equivalent to 15kJ per circle. The temperature of the sink=17°C

(4Marks)

(f) (i) What is a spontaneous process

(2Marks)

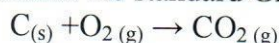
(ii) State any three examples of physical and chemical properties that can be used to explore the idea of spontaneity

(3Marks)

**QUESTION TWO (20 marks)**

(a) Calculate the standard Gibbs free energy for the reaction at 25°C

(5Marks)



$$(\Delta H^\circ = -393.4 \text{ kJ mol}^{-1}, \Delta S = 2.9 \text{ J K}^{-1})$$

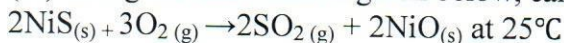
(b) (i) State the third law of thermodynamics

(2Marks)

(ii) Define the term entropy

(2Marks)

(iii) Using the information given below, calculate the entropy of the reaction



(6Marks)

	$S^\theta \text{ J K}^{-1} \text{ mol}$
$SO_2$	248
$NiO$	38
$NiS$	53
$O_2$	205

(c) (i) What is a state function

(2Marks)

(ii) State any three examples of state functions

(3Marks)

**QUESTION THREE (20 marks)**

(a) (i) Using  $E = q - W$ , show that heat of an isothermal reversible process is

$$q = nRT \ln \frac{V_2}{V_1} \quad (5\text{Marks})$$

(ii)  $2 \text{ dm}^3$  of hydrogen initially at stp are expanded isothermally to a volume of  $4 \text{ dm}^3$ . Calculate work done assuming ideal behaviour of hydrogen **(5Marks)**

(b) Using kinetic theory show that  $C_v = \frac{3}{2}R$  **(5Marks)**

(c) (i) Define heat engine **(2Marks)**

(ii) Show that efficiency of a machine ( $\eta$ ) is given by  $\eta = 1 - \frac{T_2}{T_1}$  **(3Marks)**

#### QUESTION FOUR (20 marks)

(a) (i) State the second law of thermodynamics **(2Marks)**

(ii) Starting with  $E = q - W$ , Show that entropy change of a system when temperature and volume are variables is given by  $\Delta S = \left[ nC_v \ln \frac{T_2}{T_1} + nR \ln \frac{V_2}{V_1} \right]$  **(10Marks)**

(iii) For one mole of a gas when temperature and volume are variables the entropy is given by;

$\Delta S = \left[ C_v \ln \frac{T_2}{T_1} + R \ln \frac{V_2}{V_1} \right]$ . Using this expression show that entropy of an isothermal process is

$$\Delta S = \left[ R \ln \frac{P_1}{P_2} = R \ln \frac{V_2}{V_1} \right] \quad (5\text{Marks})$$

(b) Distinguish between isobaric and isochoric processes **(3Marks)**

#### QUESTION FIVE (20 marks)

(a) Using the ideal gas equation. Derive and state the physical significance of gas constant R **(5 marks)**

b) Using the first law of thermodynamics ( $dE = dq - pdv$ ), show that the specific heat capacity at constant pressure is given by  $C_p = \left( \frac{dH}{dT} \right)$  **(10Marks)**

(c) Using kinetic theory, show that  $C_p - C_v = R$  **(5 marks)**